

Materials Science Department – CENIMAT|I3N

Transparent Electronics and Nanofabrication

CENIMAT|I3N / Materials for Electronics, Optoelectronics and Nanotechnologies Group



UNINOVA

**FCT** FACULDADE DE  
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## Objectives

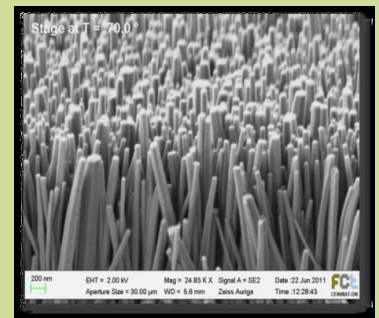
- Integration of n- and p-type oxide (thin film and nanowires) TFTs in transparent electronic circuits (CMOS inverters, ring-oscillators, current mirrors, etc).
- Indium-free oxide nanowires with semiconductors (based on Zn, Sn, Cu) fabricated using low cost and low temperature solution processes.
- Implementation and characterization of different device architectures for oxide nanowire transistors and circuits.
- Integrate devices and power sources based on metal oxide nanowires on flexible substrates turning them energetically self-sustainable and low-cost.

## Methodology

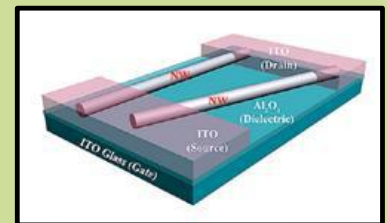
- Synthesis of solution processed oxide nanowires and deposition on flexible substrates using transfer and direct growth methods, for nanocircuits fabrication (r.f. and d.c. magnetron sputtering, e-beam evaporation, parylene deposition, RTA, microwave synthesis, reactive ion etching coupled with ICP, optical mask aligner, photoresist development and coating spinners).
- Study and optimization of different transfer methods of oxide nanowires to flexible substrates, to obtain precise alignment, positioning and uniform density distribution of nanowires.
- DC and AC electrical characterization of the nanocircuits or electrical measurements with SEM-FIB using nanomanipulators, to access specific regions of the nanocircuits.

## Expected Results

- Synthesis of high-quality oxide semiconductor and metal nanowires by liquid-phase methods on flexible substrates at temperatures below 150°C.
- Implementation of the produced metal oxide nanowires in devices with high performance, using random networks and arrays of aligned nanowires:
  - Stable ( $\Delta V_T < 0.5V$ ) and high- $\mu$  ( $> 500 \text{ cm}^2/Vs$ ) n- and p-type oxide transistors.
- Fabrication of transparent and flexible electronic circuits with high density.



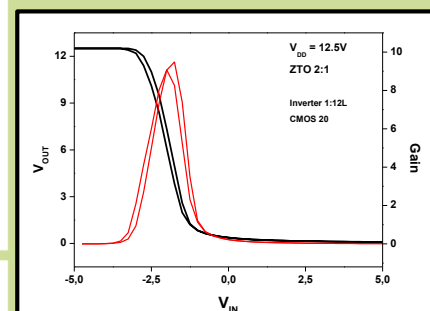
Aligned ZnO nanowires on ZnO:Ga thin film seed layer fabricated at FCT-UNL



ZnO single-NW transistor. Ju et al., Nat Nano 2 378-384 (2007)



Transparent devices in flexible substrate fabricated at FCT-UNL



Transparent and flexible CMOS inverter (with ZTO + SnO and GAZO) fabricated at FCT-UNL